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Drivers of flood damage on event level

IAHS Panta Rhei Working group "Changes in Flood Risk" *

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* For more information on the working group see: http://iahs.info/uploads/Panta%20Rhei/Working%20Groups/wg19.pdf
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Poster-
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Background and Objective

Flood risk is dynamic and influenced by many processes related to hazard, exposure and vulnerability. Flood damage increased significantly over the past decades, however, resulting overall economic loss per event is an aggregated indicator and it is difficult to attribute causes to this increasing trend.

Much has been learned about damaging processes during floods at the micro-scale, e.g. building level. However, little is known about the main factors determining the amount of flood damage on event level.

Thus, we analyse and compare paired flood events, i.e. consecutive, similarly damaging floods that occurred in the same area. In analogy to 'Paired catchment studies' - a well-established method in hydrology to understand how changes in land use affect streamflow – we will investigate how and why resulting flood damage in a region differed between the first and second consecutive flood events.

Figure 1: What drives the damage on event level? Example: June 2013 flood in Germany

Approach

A meta-study approach is followed by undertaking mainly qualitative analyses of nine paired flood event studies (Figure 7). The theoretical foundation of our analyses is the IPCC SREX concept of disaster risk (Figure 2), thus for all case studies quantitative to qualitative indicators for hazard, exposure and vulnerability are developed and compared (Tables 1 and 2).

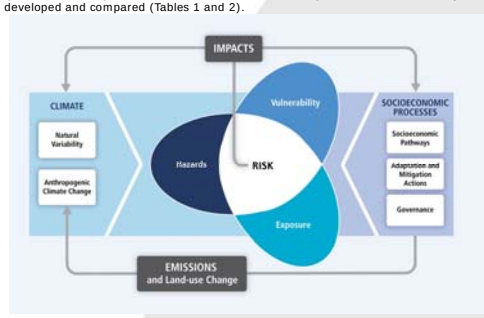

Figure 2: Analyses follow the IPCC SREX concept of disaster risk (Kundzewicz et al. 2014).

Example: Paired flood events - 2002 and 2013 floods in Germany

In August 2002 severe flooding occurred in the Elbe and Danube catchments. In Germany, the flood of August 2002 caused 21 fatalities and 108 injured people as well as overall financial losses of EUR 11,600 million (Figure 3).
The flood in June 2013 caused large-scale flooding affecting almost all main river basins in Germany (Merz et al. 2014; Schröter et al. 2015). The flood caused 14 dead and 128 injured people. The overall financial losses are estimated to be about EUR 6,000 million (Thieken et al. 2016).

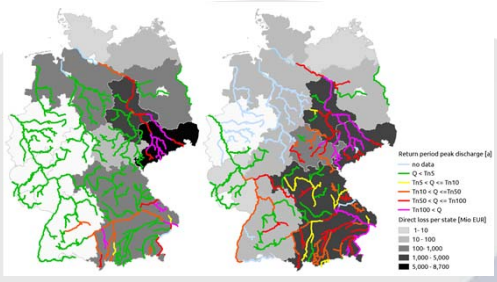

Figure 3 Overview of the 2002 (left) and 2013 (right) flood events in respect to return periods and resulting losses

Table 1: Semi-quantitative comparison of the paired flood events: 2002 and 2013 floods in the Elbe and Danube catchments in Germany

		2002 flood	2013 flood
Hazard	Pre-conditions (Schröter et al. 2015)	Wetnessindex: 47	Wetnessindex: 114
	Precipitation (Schröter et al. 2015)	Precipitationindex: 30	Precipitationindex: 17
	Hydrological severity (Schröter et al. 2015)	Severityindex: 35	Severityindex: 75
	Protection failures	131 dike failures	30 dike failures including 3 major breaches
Exposure	Number of people affected	330,000	600,000
	Settlement area affected	30 km²	No data
	Exposure hotspots	Dresden, municipalities on the river Mulde (e.g. Grimma, Eilenburg, Bitterfeld, Dessau)	Passau, Deggendorf, Halle (Saale), Magdeburg, Lauenburg
Vulnerability	Awareness	Last severe floods were in 1974 and 1954 respectively, major administrative and societal changes due to reunification of Germany	Several consecutive floods in Elbe and Danube catchments since 2002; but hazard and risk maps are hardly known by the public
	Preparedness	Warnings were relatively late and imprecise, administration as well as affected people and companies were not well prepared for emergency management	Considerably improved chain of detection, warning and alerting, reaction and behaviour on community, household/company level
	Organisational emergency management	Exercises within individual relief organisations	Every two years, there is a trans-organisational national crisis management exercise (LÜKEX); changes and improvements also on municipality level

A detailed comparison of the two consecutive flood events in terms of hazard, exposure and vulnerability (DKKV 2015) revealed that affected parties and authorities learned due to the extreme flood in 2002, and that considerable improvements are achieved, in particular in

1) increased flood prevention by improved spatial planning,
2) increased number of property-level mitigation measures,
3) more effective early warning and improved coordination of disaster response
4) targeted maintenance of flood defence systems and their deliberate relocation.

Examples of detailed comparisons focused on companies

Figures 4 to 6 show examples of detailed comparisons between the 2002 and 2013 floods in Germany focused on companies damage and warning (DKKV 2015). Results are based on surveys undertaken after both flood events. Several of such analyses were used to develop and underpin the semi-quantitative indicators for Tables 1 and 2.

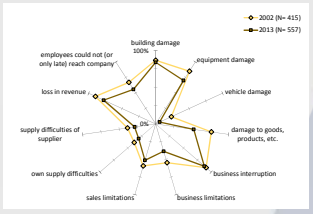

Figure 4: Fractions of companies affected by different types of damage

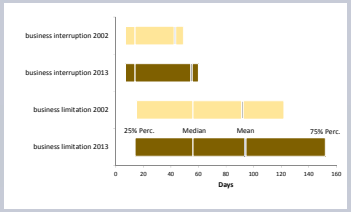

Figure 5 Duration of business interruption and business limitation of companies

Figure 6 Overview if and how companies became aware of the imminent flood danger

Case studies: Paired flood events

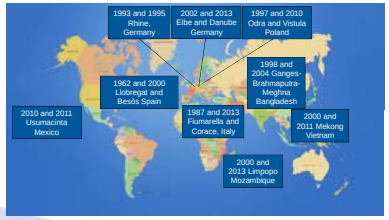

Figure 7 Overview of paired flood event studies (years of flood occurrences, catchments, country)

Pattern of paired flood event studies

Table 2: Qualitative comparison of the paired flood events. Importance of potential damage drivers in the paired flood events (D = Germany; P = Poland; I = Italy; C= Catalonia/Spain; M= Mexico; V=Vietnam; B=Bangladesh; Mz=Mozambique; damage reducing effect: green, neutral/common effect: gray, damage increasing effect: red; high damage reduction: ↓↓ , medium damage reduction: ↓, no damage reduction: →)

		D 2002	D 2013	D 1993	D 1995	P 1997	P 2010	I 1987	I 2013	C 1962	C 2000	M 2010	M 2011	V 2000	V 2011	B 1998	B 2004	Mz 2000	MZ 2013
Hazard	Pre-conditions																		
	precipitation																		
	Hydrological severity																		
	Protection failures																		
Exposure	Number of people affected																		
	Settlement area affected																		
	Exposure hotspots																		
Vulnerability	Awareness																		
	Preparedness																		
	Organisational emergency management																		
	Damage reduction	↓		↓↓		↓		↓		↓↓		→		↓↓		↓		↓↓	

Conclusions

- In nearly all cases of consecutive floods, there is a clear reduction in damage. This seems to be mainly related to decreasing vulnerability.
- Paired flood event studies show large decreases in vulnerability, medium reductions in damage and small changes in exposure from first to second event.

-> Societies seem to learn

- Paired flood event studies offer potential for understanding changes in flood risk systems, however, case studies show that influences are various and selection of studies may be biased.

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